

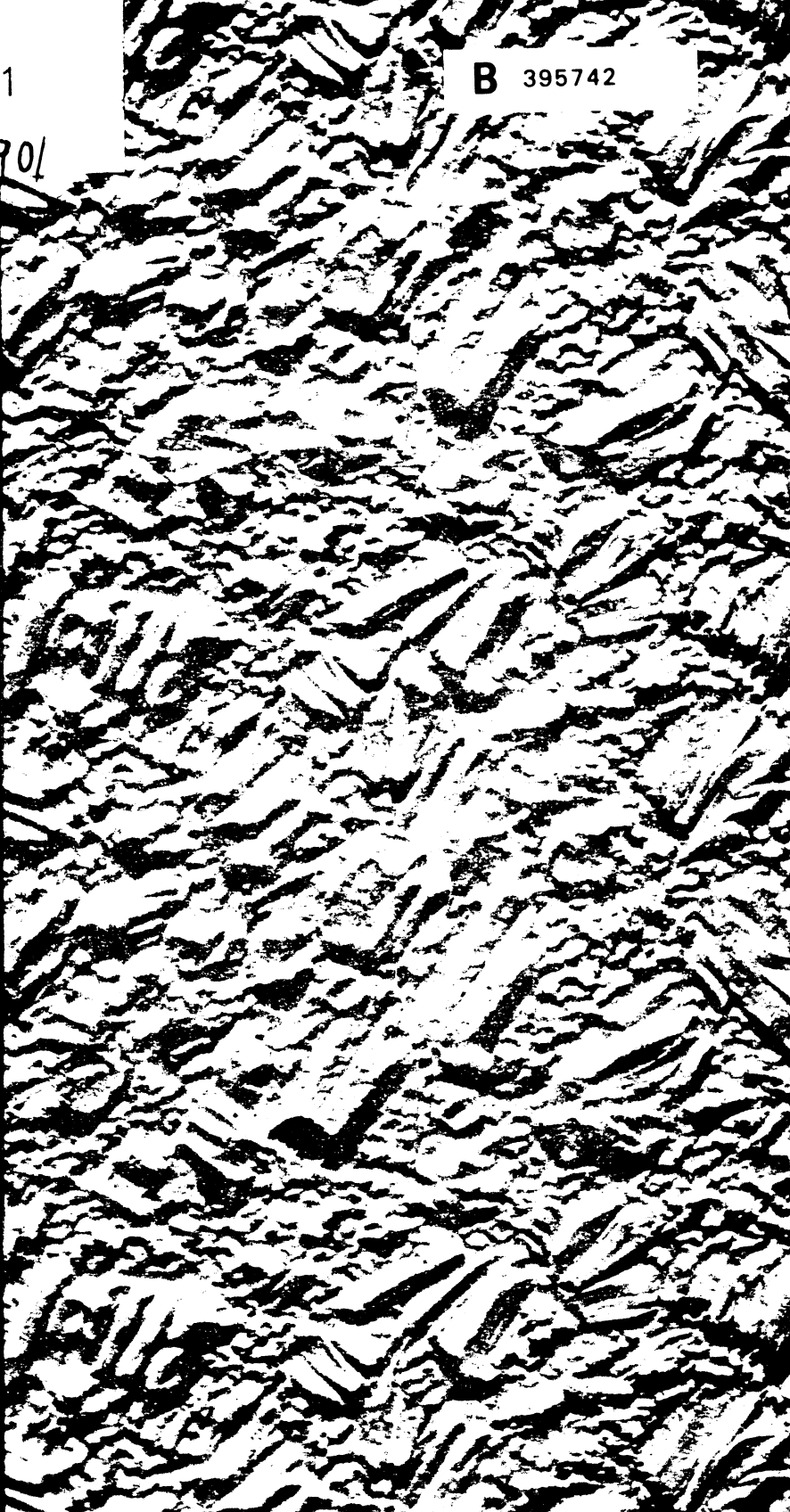
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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
A. C. TRUE, DIRECTOR.

ANNUAL REPORT OF THE PORTO RICO AGRICULTURAL
EXPERIMENT STATION FOR 1901.

BY

F. D. GARDNER,
Special Agent in Charge.

[Reprint from Annual Report of the Office of Experiment Stations for
the year ended June 30, 1901.]

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By F. D. GARDNER, *Special Agent in Charge.*

INTRODUCTION.

The first appropriation for agricultural investigations in Porto Rico was made for the fiscal year ended June 30, 1901. This appropriation was \$5,000, and authorized the Secretary of Agriculture to determine the agricultural conditions existing in that island with special reference to the most desirable localities for agricultural experiment stations, as well as the subjects on which the agricultural people of the island are in most immediate need of practical information, and how this need can be most economically and effectively supplied; but it did not provide for the establishment and maintenance of an experiment station. The preliminary investigation called for by this appropriation was made through the Office of Experiment Stations by Prof. S. A. Knapp, formerly of the Iowa Agricultural College, and more recently engaged in agricultural enterprises in southern Louisiana. He visited Porto Rico during the summer of 1900, and made his final report in September of that year. This report was transmitted to Congress and published as House Doc. No. 171 (Fifty-sixth Congress, second session). It contains a summarized statement regarding the climate, soil, and agriculture of the island, shows in what ways the experiment station might benefit agriculture, and recommends the establishment of a station as soon as practicable. Professor Knapp advises that the station should give immediate attention to promoting the production of larger and better crops of coffee, sugar, and tobacco, and food products for home consumption, and that at an early day work should be undertaken in horticulture, forestry, animal husbandry, and dairying. Besides conducting experiments, it should give object lessons in improved farming and should disseminate information by publications and agricultural meetings.

On the basis of this report Congress made a second appropriation (\$12,000) for the current fiscal year, which authorized the Secretary of Agriculture "to establish and maintain an agricultural experiment station in Porto Rico, including the erection of buildings, the printing (in Porto Rico), illustration, and distribution of reports and bulle-

tins, and all other expenses essential to the maintenance of said station."

Though this appropriation did not become available until July 1, 1901, the writer, then assistant in the Division of Soils of this Department, was transferred to the Office of Experiment Stations April 15, 1901, and was appointed to take charge of the agricultural investigations in Porto Rico. After spending some time in such preliminary preparations as could best be conducted in Washington and vicinity, he proceeded to Porto Rico, arriving in San Juan about the middle of May. The remaining portion of the fiscal year he spent mostly in traveling about the island to familiarize himself with its people and the conditions and needs of agriculture, with special reference to the location of the experiment station and the character of experiments most desirable to undertake. During a portion of this time he was accompanied by Messrs. O. F. Cook and G. N. Collins, of the Division of Botany, of this Department, who had been temporarily assigned to this Office and sent to Porto Rico to aid in preliminary studies with reference to the determination of the best lines of work for the proposed experiment station.

As regards the location of the experiment station, more difficulty was experienced in obtaining suitable land than was anticipated. Replies to a circular letter sent to the different municipalities in the island, setting forth some of the advantages of an agricultural experiment station, and asking how much land they would donate for the purpose of establishing an experimental farm in their vicinity, as a rule, stated that the municipalities possessed no lands that in kind and amount would be suited for the purpose, and that their very poor financial condition would not allow them to purchase. Three municipalities, however, made offers of land, but on examination it was found to be either not suitable for experimental purposes or too inaccessible.

When it became apparent that the station could not be permanently located without considerable delay, arrangements were made for conducting experiments on a temporary basis. Thirty acres of land adjacent to the town of Rio Piedras has been leased, together with a large frame house which serves as a residence and office for the special agent, and also furnishes accommodations for laboratories and library. In addition to this, the local normal school has donated temporarily the use of 40 acres of land for experimental purposes. The necessary horses, mules, and oxen have been secured and a stable constructed for their shelter. A farm wagon, an ox cart, and several plows and harrows, together with garden and horticultural tools, have been secured. A portion of the land has been cleared of weeds, banana stumps, etc., and plowed. The experiments include tests of various kinds of plants, and experiments regarding the time and manner of planting, the use of fertilizers, etc. A cooperative experiment has been commenced on

a coffee plantation, with the object of improving methods of growing coffee in Porto Rico. This consists of an attempt to improve the yield and quality of coffee by selection, breeding, and propagating, and in restoring old groves by removing part of the shade and thinning and pruning. Investigations have also been begun to discover means for combating certain troublesome insects, especially the "changa," a kind of mole cricket, and various scale insects, and the fungus diseases affecting citrus fruits.

The Bureau of Soils of this Department, in cooperation with the station, has undertaken a soil survey of a portion of the island. A considerable number of different kinds of vegetable seeds have been distributed to farmers. The beginning has been made of a collection of improved farm implements and machinery of the kinds adapted to the tropical agriculture of the island. In this work the station has been greatly aided by different manufacturers in the United States. It is believed that in this way useful information regarding improved implements will be disseminated by visitors to the station.

The organization of a regular station staff has been begun, the force now including the special agent in charge, the entomologist and botanist, and farm foreman.

It is hoped that land may be obtained for the permanent location of the station in the near future and that it will be possible to greatly develop the work of the station during the coming year. Considering the large agricultural interests of the island and the variety of work which needs to be done by the station, the appropriation for its support by Congress should not be less than \$15,000 per annum. In addition to this, money will be needed for the purchase of land, erection of buildings, and equipment of the station. The station will, therefore, need such financial assistance from the Territory of Porto Rico as was given in the other States and Territories.

There are no results of experimental work to be reported at this time. This report is, therefore, chiefly confined to a statement of the agricultural conditions and needs of the island as seen by the writer in the course of such an agricultural survey as he has been able to make in the space of nine months.

AGRICULTURAL RESOURCES AND CAPABILITIES OF PORTO RICO.

LOCATION AND EXTENT.

Porto Rico is situated between $65\frac{1}{2}^{\circ}$ and $67\frac{1}{4}^{\circ}$ east longitude and 18° and $18\frac{1}{2}^{\circ}$ north latitude. It is therefore approximately 5° south of the Tropic of Cancer or well within the Torrid Zone. It is roughly, 11° east and 22° south of New York City, or 12° south by 24° east from New Orleans. The air-line distance from the island to New York City

is about 1,400 miles, while the distance to New Orleans is slightly greater.

In form the island is a parallelogram, with its long axis extending almost due east and west. In extent it is 36 miles wide by 100 miles long, embracing an area of 3,600 square miles.

CONFIGURATION.

The topography of the island consists chiefly of interior mountains and coast border plains, the latter representing only about one-tenth of the whole. The formation of the island is volcanic, the rocks consisting principally of limestones, together with small amounts of granite, marble, sandstone, and serpentine. The limestone varies greatly in its character and hardness. In the interior it is usually of a blue or grayish crystalline nature, and well adapted for burning into lime, although but little used for this purpose. The surface of these rocks is almost entirely disintegrated, forming a soil several feet in depth, which gives to the mountains a smooth appearance and furnishes a good footing for vegetation. Along the marginal foothills the limestone is of a white and chalky appearance, and is sponge-like in texture. It is usually spoken of as coral limestone, and the cavities often contain seashells. This coral limestone gives rise to foothills, having very steep acclivities, and terminating in very sharp and jagged points. The rocks are more exposed than in the interior, but their porous nature furnishes a good footing for plants, and the hills are usually covered to their summits with verdure. These rocks are much used in the construction of roads.

The main backbone of the island extends almost due east and west and is fully two-thirds of the distance to the south side. The watershed of the north is therefore twice as extensive as that of the south, and because of the greater rainfall on the former, the rivers are more than correspondingly larger.

The coastal plain consists chiefly of level stretches of alluvial land which in places takes on an undulating aspect. In a number of places this coastal plain is broken by the mountains coming directly to the seashore. It rarely extends inland more than 5 miles and the greatest breadth usually occurs at the mouth of the larger rivers.

The interior mountain country is cut by numerous streams which ramify in every direction and give rise to deep but very narrow valleys. The river bottom lands are in small irregular areas which occur first on one side of the stream and then on the other as it sweeps the valley from side to side in its course to the sea. In many places no bottom lands are present, the valley being so narrow that it is occupied only by the rocky bed of the river.

In a few instances the valleys widen out into a considerable area of bottom lands. The most noted example of this is at Caguas, where

occurs a considerable area of level land, now devoted to the growing of sugar cane. This, however, is supposed to have been a coastal lagoon or lake, which became filled with sediment and was brought to its present elevation (about 250 feet) and position by the uplifting of the island.

The mountains, while rugged, scarcely ever exceed 3,000 feet in elevation. No topographic survey has ever been made of the island, though one is much needed, and, consequently, reliable data as to elevations are wanting. The highest eminence is attained on El Yunque, in the northeast part of the island. Spanish maps give this mountain an elevation of 4,087 feet, but other authorities give it as much less, the minimum being 3,200 feet. These mountains may be considered nothing more than the peaks of a part of a great mountain chain, which, if wholly emerged, would exceed in elevation any mountains on the North American continent. To the north the shore of the island drops off rapidly, and within less than 75 miles the water attains a depth of 4,600 fathoms, or more than 5 miles.

The elevations of Porto Rico are not sufficient to cause any marked change in temperature, but owing to the prevailing direction of the winds they have a marked effect on the distribution of the rainfall. The combined influence of soil, rainfall, and elevation, however, has a marked effect upon the character of the vegetation and makes climatology a subject of vast importance.

SOILS.

The soils vary much both in formation and texture. About the shore occurs a narrow fringe of coarse coral sand, which results chiefly from the breaking down of the coral growth that is continuously in process in the waters near the shore. This soil, with its accompanying salt-water climate, is adapted to a comparatively limited flora, which is quite distinct from that of the interior. Here the cocoanut palm, yarey palm, and the sea grape find a congenial home, and the soil seems well adapted to the growing of pineapples. Bordering this to the landward are two types of soil, viz, the mangrove swamps and the playa plains. The former are swamp areas, which are about midway between high and low tide in elevation and are, therefore, inundated to the depth of about a foot by every rise of tide. The soil is often made up of a mixture of the coral sand and the finer material which is brought down from the interior, together with much organic matter resulting from the decay of the falling leaves of the mangrove bushes, which gives to the soil a black color. The soil is necessarily charged with salt and has no economic value except for the purpose of future reclamation by diking and pumping.

The soils of the playa plains, owing to the sources of their origin, vary much in character. They are all alluvial, however, and brought

down from the interior. On the north side of the island they usually consist of sandy loam, or loam which is underlaid at a depth of 12 inches by a medium clay. They are level, and when properly drained and cultivated make excellent sugar and pasture lands. On the south side of the island this soil is much deeper and usually more sandy as well as darker in color. For the production of sugar it requires irrigation during the dry season.

Bordering the playa plains are the foothills or mountains, the soils of which are dark in color. Farther inland, however, the soil is usually of a heavy red clay. The soils are adapted to coffee, citrus fruits, bananas, tobacco, and various other minor crops, the heavy clays being especially well adapted to coffee.

The coral sands and the playa plains are so level that improved machinery could be used to very good advantage in their cultivation, but the interior country is so rugged that it prohibits the profitable use of the most of our horse machinery.

The accompanying table gives the mechanical analysis of samples of soil and subsoil from various parts of the island:

Mechanical analysis of soils and subsoils from Porto Rico.*

No.	Locality.	Description.	Gravel larger than 2 mm.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
5918	Cayey, 5 miles W.	Tobacco land, 0 to 18 inches.	45.9	8.16	1.74	5.30	4.70	15.32	12.20	27.10	26.18
5925	Rio Piedras.....	Sandy soil, 0 to 10 inches.	Tr.	3.76	1.02	19.76	15.60	25.60	8.64	9.08	15.02
5926	.....do.....	Subsoil under 5925, 12 to 30 inches.	.7	5.14	1.66	12.28	11.46	23.00	7.80	7.10	30.98
5916	Mayaguez.....	Heavy loam, 0 to 18 inches.	2.9	11.62	.46	1.92	1.42	5.50	7.80	29.18	42.26
5917	.....do.....	Lowland, 0 to 12 inches.	2.9	11.54	.26	.50	.32	1.16	1.34	18.66	65.80
5920	Yauco, 3 miles SW.	Cane land, 0 to 12 inches.	2.5	6.74	1.16	3.30	2.40	7.82	7.42	23.30	48.20
5924	Ponce, 3 miles E..	Cane land, 0 to 18 inches.	2.4	7.32	.46	1.88	1.58	5.84	6.64	29.78	46.38
5921	Mamayas post-office.	Virgin forest, 0 to 6 inches.	Tr.	15.24	.22	.44	.46	1.24	1.28	19.46	61.18
5922	.....do.....	Good coffee land, 0 to 6 inches.	Tr.	10.06	.08	.34	.36	.70	1.04	12.74	75.32
5923	.....do.....	Subsoil under 5922, 6 to 24 inches.	.....	8.26	.00	.12	.14	.86	1.46	11.90	77.84

* Made by the Bureau of Soils, U. S. Department of Agriculture.

Sample No. 5918 is representative of the hillside soils of the Rio La Plata which are used for tobacco. The analysis is of material smaller than two millimeters in diameter, and takes no account of 45.9 per

cent of angular gravel or broken stone which the sample contained. This soil contains a considerable percentage of sand, which, together with the contained stone, makes it loose and friable. It admits of the ready permeation of rains, and retains moisture well.

Nos. 5925 and 5926 are soil and subsoil, respectively, from level land at Rio Piedras which has been leased for cultural experiments by the station. Owing to its sandy nature it was considered especially well adapted to the growing of annual crops, particularly vegetables. The soil to 10 inches in depth is sufficiently sandy to make it easy of cultivation, while the subsoil at 12 to 30 inches contains sufficient clay to make it retentive of fertilizers and yet sand enough to make good drainage comparatively easy.

Nos. 5917 and 5916 are from the land of the Agronomic Experiment Station, which was maintained at Mayaguez by the Spanish Government from 1889 to 1897. This land, consisting of 7 acres, is of two types - a low, level portion classed as a heavy loam and adapted to the growing of sugar cane and grass, and a hilly part classed as a red clay. The latter is a heavy refractory clay, identical with that of the best coffee lands of the interior. It contains an aggregate of $3\frac{1}{2}$ per cent of sand and larger amounts of silt and clay. The content of organic matter is not real, for in soils of this character the loss in heating to 100° C. is partly due to the loss of water of crystallization. If of higher elevation and farther removed from the coast this would be typical coffee land.

Nos. 5920, from near Yanco, and 5924 from near Ponce, are from the heavier type of loam soils now used for the growing of sugar cane on the south side of the island. Their content of clay and silt is sufficiently high to demand careful management in irrigation and cultivation.

No. 5921 is the surface soil, 0 to 6 inches, from a virgin forest in Mamayes. This soil is almost wholly silt clay and organic matter. The high content of the latter is due to a considerable coating of vegetable mold, the result of the decaying leaves from the forest. This land, when cleared, will be typical for coffee.

Nos. 5922 and 5923 are the soil and subsoil from a young coffee plantation at Isolina, Mamayes. The soil is red in color and very heavy in texture. It clings tenaciously to the sidehills, which are so steep that good drainage is always afforded, and even with the torrential rains is subject to but little washing. As will be seen from the analyses, this is a very heavy soil, and in case of the subsoil contains less than 3 per cent of all grades of sand. It is considered representative of the best coffee lands of the interior. These analyses emphasize the extremely heavy texture of the mountainous coffee lands, and enable one to better understand why so little of the soil is carried away from the steep slopes by the torrential rains.

CLIMATE

The climate of Porto Rico is characterized by a very uniform temperature, abundance of rain, plenty of sunshine, high relative humidity, and moderate to slow wind movement. The mean annual temperature for the island is about 78° F. The warmest weather occurs in July, August, September, and October, and the coldest in January and February. The difference in temperature, however, between the hottest and coldest month is only about 8° F. The changes from day to day and from month to month are so slight that they are scarcely perceptible. The greatest annual difference in temperature in different parts of the island, as determined by seventeen United States Weather Bureau stations in 1900, was only 4.8° F. The mean temperature is slightly lower in the elevated parts of the island than along the seashore. The weather is perpetual summer, with three hundred and sixty-five growing days in each year.

The annual rainfall varies greatly, attaining a maximum of 140 to 150 inches in the northeast part of the island, near El Yunque, and a minimum of about 40 inches in places near the southern coast.

The following table shows the monthly precipitation for each of four localities on the island since the establishment of observations there by the United States Weather Bureau. Prior to that period the only continuous record is one that was kept at San Juan by the Spanish Government. The mean of this station for twenty-six years is as follows: Temperature, 78.5°; rainfall, 54.51 inches.

Rainfall (inches) in Porto Rico as recorded by the United States Weather Bureau, January, 1899, to December, 1901.

Locality.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Hacienda Perla:													
1899.....	7.19	3.98	6.51	18.78	6.72	11.47	10.55	9.92	15.43	16.53	28.13	4.92	140.06
1900.....	12.05	3.67	4.43	23.34	18.70	18.55	11.04	11.95	15.30	15.83	8.86	8.70	151.92
1901.....	6.07	1.85	11.03	7.05	16.26	25.34	33.58	8.19	16.10	14.16	16.43	.....	.....
Mean.....	8.44	3.17	7.32	16.39	13.56	18.45	18.39	10.02	15.61	15.51	17.64	.....	.....
San Juan:													
1899.....	2.92	.80	2.29	6.09	2.59	7.23	7.53	10.38	13.66	10.21	11.81	2.10	77.61
1900.....	3.93	2.13	1.57	5.92	3.83	7.53	6.33	7.00	3.05	8.11	4.50	2.39	56.29
1901.....	4.36	.50	4.60	.66	4.84	7.05	10.98	8.59	7.39	8.30	9.55	.....	.....
Mean.....	3.74	1.14	2.82	4.22	3.75	7.27	8.28	8.66	8.03	8.87	8.63	.....	.....
Mayaguez:													
1899.....	.....	.....	.....	.....	.....	.....	14.41	19.02	.....	8.73	3.52	1.04	.....
1900.....	1.49	1.06	1.21	5.44	6.14	14.03	13.11	14.02	7.44	12.47	2.99	4.20	83.57
1901.....	2.19	.58	5.72	.58	11.87	10.44	17.06	9.85	13.00	11.27	12.84	.....	.....
Mean.....	.....	.....	.....	.....	.....	.....	14.86	14.30	.....	10.86	6.45	.....	.....
Hacienda Armistad:													
1900.....	4.25	.80	1.00	1.10	2.80	16.30	5.50	2.20	4.80	4.46	3.83	4.22	51.26
1901.....	2.60	1.14	2.63	.32	6.30	4.84	.....	6.03	7.97	6.30	13.97	.....	.....
Mean.....	3.42	.97	1.81	.71	4.55	10.57	.....	4.12	6.38	5.38	8.90	.....	.....

A study of the above table shows that the montly rainfall goes as high as 33.58 inches and as low as 0.50. A rainfall of 10 or more inches in twenty-four hours is not uncommon. In July of the present year a rainfall of 17 inches in twenty-four hours is recorded at Hacienda Perla and of 10 inches in twenty-four hours at Adjuntas. The table also shows that the driest months of the year are January, February, March, and December. The dry season, as these months are called, varies in time and duration from year to year and also varies for different portions of the island. On the south side of the island the dry season often continues into the month of July. During the present year the fields all along the south side of the island not under irrigation were in a brown and parched condition as late as July 1.

The prevailing wind is from the northeast, and in rising to pass over the mountains it is cooled to such an extent that a part of its heavy charge of humidity is condensed and falls as rain on the north side of the island. It is for this reason that the rainfall of the north slope so far exceeds that of the south. As a rule the rains occur as showers, often torrential in character, and most frequently in the afternoon. After the rain the sun again shines and nature soon resumes normal conditions. Owing to the torrential character of the rains a large part of the water finds its way into the streams, which rush madly down the steep slopes on their way to the ocean. The streams rise very quickly and often become such raging torrents that it is impossible to cross them, and there is nothing for the traveler to do but to wait for them to subside, which they usually do in a few hours. During the rainy season, however, the showers may be so frequent that the streams will continue very high for several days, thus stopping for the time all communication between different parts of the island. Excepting on the first-class roads the streams are without bridges, and even here some of these have been destroyed by the floods and will have to be replaced at a cost of many thousands of dollars.

Fogs are very common in the mountains during the early morning and often settle in the valleys so as to entirely obscure the view of one standing on the mountain top.

As a whole the climate is healthful. There is usually a breeze, and though the temperature is uniformly high it is seldom excessively warm or oppressive. With a little care people from the temperate climate need have no fear of disastrous results from the climate. It is well to avoid the sun between 11 and 2 o'clock, for at that time of the day it is almost directly overhead and very hot.

SANITARY CONDITIONS.

In the cities and towns the sanitary conditions are very bad because of the lack of city water and sewerage, and the prevalence of vaults that have been in use for several hundred years. (Pl. XXXIII, fig. 1.)

In the larger places, however, these foul conditions are being ameliorated by the installation of waterworks and sewerage, together with sanitary plumbing.

Each house usually has a water-tight cistern, which collects the rain water from the roof that is used for culinary and drinking purposes. Before using this water is passed through an earthen-ware filter to insure its purity. Since water is so often the conveyor of diseases, especially of fevers in tropical countries, it is well to boil all water used for drinking, thus destroying all germs that it may contain.

The laundering is practically all done in the streams. (Pl. XXXIII, fig. 2.) The laundress takes her pack of clothes on her head and wends her way to the nearest stream, where she sits on a rock and washes the clothes directly in the water. The clothes are afterwards spread on the dry rocks or the near-by bushes to dry. This universal habit of washing in the streams practically prohibits the using, with safety, of river water for drinking.

The houses are usually built upon piles or posts, being elevated 2 or more feet above the ground, thus giving them better ventilation and drier conditions as well as lessening the intrusion of vermin and insects. Many of the huts of the very poor, however, are built directly on the ground and without any floors, the occupants sleeping in hammocks or sometimes on the ground.

The native Porto Rican is much opposed to the night air, and therefore upon retiring he closes all of his windows and doors as tightly as possible. As large families often occupy a single room the air becomes very foul. It is believed that good ventilation, even in the night, would be conducive to better sanitary conditions.

The diet of the people varies greatly. For the very poor it consists of what they can most easily obtain with the least expenditure of either money or energy. Native fruits that grow practically wild often form a large part of their living. Rice and beans are two staple foods, and are found on the table of the rich as well as the poor. The people who can afford it eat much meat, and oils and lard are very freely used in cooking. It seems probable that animal foods are used to a much greater extent than is conducive to the best of health, especially in so warm a climate. Vegetables and maize should replace a part of the present meat diet of the people.

Naturally very little clothing is necessary, and the children of the poor, often to the age of 10 years, dispense with it.

It is not strange that in the North, where the winters are long and cold, that some people should be unable to supply the necessaries of life, but it seems almost incredible that in a tropical country, where planting and sowing can be practiced every day in the year, and where land is plenty, the mass of the people should be poverty stricken. Such, however, is the case in Porto Rico, and the reason is not on the surface of things, but is down in the primitive foundation of society.



FIG. 1. PORTO RICO STATION—STREET SCENE IN CAGUAS.



FIG. 2.—PORTO RICO STATION—WASHING CLOTHES.

LABOR.

The labor problem is one which the Northern man will find more or less perplexing. While the wages of laborers are low, it is doubtful after all if it will be found cheap. The agricultural laborer in Porto Rico is as a rule ignorant and unskilled. He has no interest in the work he is performing for his employer, and consequently requires constant supervision, otherwise he will either not work or will do things wrong. He has no desire to rise in the world or to accumulate a small property, even for a home, and when he gets a few days' wages ahead he prefers to stop work until he has spent them. There is much to be done in improving the energy and skill of the agricultural laborer. There are great numbers of men who know how to do nothing but wield a machete or a hoe. Many of them have never driven an ox team or harnessed a horse, and to do the latter properly would for them be an absolute impossibility. The training of these ignorant people in the use of the spade, scythe, ax, pruning knife, spraying apparatus, and the operation of hand and horse machinery means a revolution in the agriculture of the island, and an output of products never before equaled in its four hundred years of Spanish rule and history.

TRANSPORTATION.

Intimately related to the agricultural development of the island is the development of transportation facilities. This naturally divides itself into interior and exterior transportation, but it is the former which most concerns the people of the island. The latter will be provided for them when the demand for it is sufficient to justify, but the former must be provided for by the expenditure of several millions of dollars, which must ultimately come from the sources that are thereby benefited. The crying need throughout the island is for roads and more roads. At present the construction and maintenance of roads is entirely vested in the insular government, the districts, barrios, and municipalities having no responsibility in them whatsoever. Quite an elaborate system of first, second, and third class roads have been laid out for the island, but a number of years will necessarily elapse before these roads can be constructed, and even when completed there will still be an urgent demand for still further road building in order to reach all of the people.

The topographical character of Porto Rico makes road building comparatively expensive, and the torrential rains make prompt repairs and maintenance imperative or they soon go to destruction.

To give an idea of the cost of road construction in the island, attention is called to the present military road extending from the capital to Ponce and Guayama, together with a few shorter sections in various other places. These roads, built under the Spanish Government,

aggregate 157.7 miles, and cost approximately \$3,485,000, or at the mean rate of about \$22,000 per mile. (See Pl. XXXIV, figs. 1 and 2.)

This is all first-class road, but fully one-third of it is on nearly level country, and required very little grading. The roadbed is macadam and of excellent surface, but is usually only sufficiently wide for ox carts to pass. Since American occupancy, about \$1,000,000 have been spent on roads under the military government, and the present insular budget carries an appropriation of about \$700,000 for roads out of a total appropriation for all running expenses of the government amounting to only \$2,000,000.

The system of roads as now planned, including those already constructed, embraces 874 miles. On the basis of the former cost, \$22,000 per mile, it will require about \$14,000,000 to complete the system. Under the present management, however, and in view of the fact that part of these roads are second and third class, the total cost will probably be much reduced. It would seem advisable that, for the extension of this system so as to reach all the people, the island be divided into road districts, with a superintendent in charge of each. There should be a poll tax, with the option of working out the same on the roads under the direction of the superintendent. A small amount of labor on the present bridle paths might at least make them passable, whereas they are now at times impassible on account of the lack of care. The interior of the island is filled with idle men who could work almost any number of days on the roads with very little inconvenience to themselves, and much to their own and the island's ultimate advancement.

In railways the island is quite as deficient as in roads. The steam railways consist of disconnected sections, as follows: From San Juan to Carolina, San Juan to Camuey, Aguadilla to Hornigueros, Ponce to Yauco, aggregating in all 135 miles. There is an electric-car line from San Juan to Rio Piedras, 7 miles distant, and a horse tramway in the town of Mayaguez.

There are now areas aggregating 50,000 acres of land in a body for which there are no means of getting their produce to market except on the heads of peons or backs of mules and horses. No road passable by even an ox cart is accessible to them. Such conditions place a handicap on agricultural development and confines it to lines requiring the minimum amount of interior transportation.

LAND VALUES AND TAXATION.

Under Spanish régime most of the revenues were acquired by a consumption tax, and was therefore borne by the poorer classes. Under an American administration, however, it was found advisable to make a radical change in this respect, and therefore a property tax has been



FIG. 1. PORTO RICO STATION. MILITARY ROAD BETWEEN CAYEY AND CAGUAS.

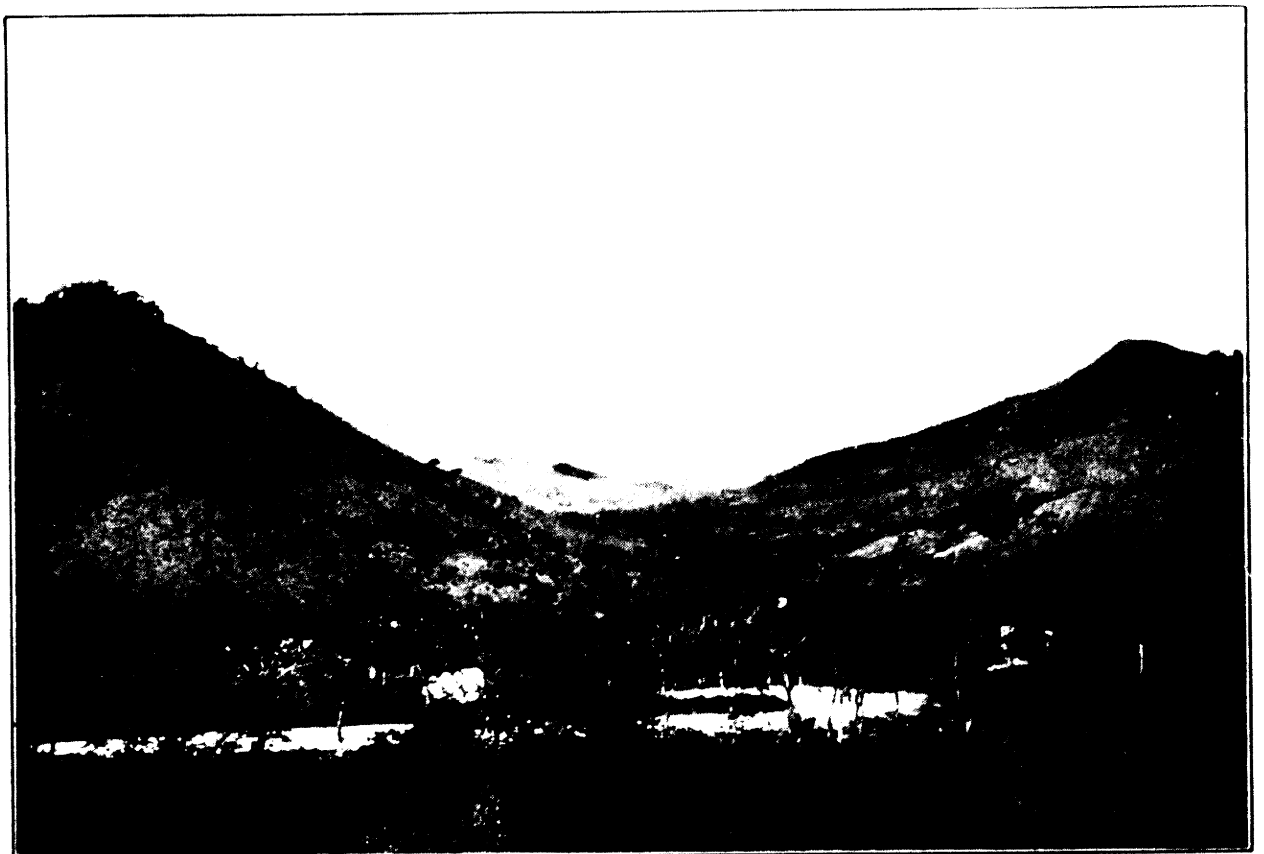


FIG. 2. PORTO RICO STATION. MILITARY ROAD NEAR COAMO.

levied, with a marked increase rate of internal-revenue tax on liquors, cigars, etc.

Formerly the landowners paid no tax on their holdings, and as a consequence many proprietors held large bodies of undeveloped and unused land with no expense. The present method of taxation makes the ownership of land an expense, and will probably result in causing much of the land either to be used for agricultural purposes or to be placed upon the market. Where lands are not on the market and not being bought or sold it is difficult to quote prices. In a general way, however, there is very little land that can be purchased for less than \$10 per acre, even when remote from roads and without improvements. Near good roads or near the towns and cities the prices advance. Cane lands vary in price from \$70 to \$200 per acre, according to kind and condition; coffee lands without coffee on them from \$10 to \$30, and with coffee trees in bearing, from \$50 to \$150, according to kind, location, and improvements. There are very few coffee plantations, however, that under the present depression for that crop can not be bought for \$100 per acre, and there are many that can be purchased at \$60 to \$70 per acre. Pasture lands range from \$15 to \$60 per acre, and will probably advance in price because they are often adapted to sugar, which industry is now in a flourishing condition.

The present law provides for a tax on lands and personal property of one-half per cent of their assessed value for insular purposes, and not to exceed an additional half per cent for local or municipal purposes. The assessed value is very nearly the actual or market value.

Land titles in Porto Rico are very poorly defined, and for many tracts no records are obtainable. This makes the transfer of property very troublesome and the title in lands more or less uncertain. There are considerable areas of Crown lands in the island, scattered about from the shores to the interior mountains, but the records relating to them are incomplete. A list of such lands, as given in the report of the commissioner of the interior for Porto Rico, while acknowledged to be incomplete, shows an aggregate of 100,000 acres. The Crown lands presumably belong to the Federal Government, but no action has thus far been taken in regard to their disposal. It is very essential to have a complete record of lands in Porto Rico, both private and public, put into the care of a competent office. All lands, and all future changes likewise, should be recorded. If necessary, a survey should be made establishing the boundaries of all parcels of land. When Congress takes up the adjustment of this matter it is suggested that a parcel of the public domain be designated for a forestry reserve, and that a limited area be also set aside for the experiment stations to be used for agricultural experiments.

AGRICULTURAL PRODUCTION.

Porto Rico is almost purely an agricultural country. Statistics show that of the exports during many years past 95 to 96 per cent were agricultural products. The chief exports are coffee, sugar, tobacco, and live stock, in the order named. The following table^a shows the important exports of commodities exceeding \$50,000 in value for the years 1894, 1895, and 1899:

Exports of commodities exceeding \$50,000 in 1894, 1895, and 1899.

Articles.	1894.		1895.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>	<i>Pounds.</i>	<i>Dollars.</i>
Coffee.....	50,507,159	11,496,082	40,243,693	9,159,985	45,328,298	5,164,210
Sugar.....	106,723,699	3,169,895	132,147,277	3,905,741	99,160,293	2,670,288
Molasses.....	15,957,253	244,466	35,219,823	539,571	* 3,415,058	647,373
Leaf tobacco.....	3,369,616	619,474	3,665,051	673,787	3,313,534	331,729
Cattle.....	4,306	166,212	3,674	141,816	.....	^b 852,167
Hides and skins.....	762,197	63,389	646,884	53,799	.....	71,975

^a Gallons.

^b Cattle are not shown separately; includes all animals.

Of the total exports of the island for the years 1887-1891, inclusive, 28.7 per cent went to the United States, 21.4 per cent to Spain, and 19 per cent to Cuba, with lesser amounts to various other countries, and for the five years ending 1896, 24.8 per cent went to Spain, with 23½ to Cuba, and 15.8 to the United States. Of the total imports of the island for the years 1887 to 1891, inclusive, 24 per cent were received from the United States, 28 per cent from Spain, with approximately 21 per cent from the United Kingdom, and lesser amounts from various other countries. For the five years ended 1896, the percentages are as follows: Spain, 32½; United States, 24; United Kingdom, 13. Since American occupancy, however, this order of importation and exportation has been very much modified and we find that for the year 1899, 40 per cent of the imports were received from the United States, with 20 per cent from Spain and 17 per cent from the United Kingdom, and for the same year, 34 per cent of the exports were sent to the United States, with 21 per cent to France, 13 per cent to Cuba, and only 10 per cent to Spain. During the first year of civil government, ended April 30, 1901, 80 per cent of the imports were received from the United States and 64.6 per cent of the exports went to the same source. This shows a marked increase between the trade of Porto Rico and the United States and we can safely predict that it will continue to increase until 90 or more per cent of both the export and import trade will be between the island and the States. During the years 1887 to 1891, the mean annual excess of imports over the

^a Figures from Monthly Summary of Commerce of the Island of Porto Rico, April, 1900, War Department.

exports was \$1,863,473 and for the following five years the mean was \$1,090,453.

Of the imports, slightly more than 40 per cent are agricultural products, much of which might be produced on the islands, thereby reducing the amount of imports perhaps to a less value than the exports, greatly to the benefit of the island. Rice heads the list of imports, and in 1895 reached the enormous amount of 74,145,046 pounds, valued at \$2,271,819. Other agricultural imports for the same year, in the order of their value, are: Hog products, \$1,274,618; wheat flour, \$1,023,694; wines, \$431,536; vegetables, \$400,660; cheese, \$337,790, and canned goods, \$178,536.

Of the nonagricultural imports cotton fabrics lead, with a value of \$2,070,667, and are followed by fish, valued at \$1,918,107.

In speaking of the present financial condition of Porto Rico, the Secretary of the Treasury reports as follows:

Without a dollar of funded or floating indebtedness, with a current income estimated as sufficient to meet the ordinary expenses of the government, with large reserve funds to provide for unforeseen or extraordinary contingencies, and with a lighter burden of taxation upon the real economic life of the island than at any time in its past history, there seems every reason for regarding the financial future of Porto Rico as bright and auspicious.

Statistics show a small falling off in both exports and imports for the past two years as compared with those preceding 1899. This, however, is accounted for by the great damage which was done to the coffee and other industries of the island by the hurricane of August, 1899. The plantations were temporarily ruined, and the value of export coffee for the year was reduced to about half its normal, with large reductions also in sugar and tobacco. The exports of coffee for 1899 are for the calendar year, and a large amount of it is from the crop of 1898. In 1900, the coffee exportations reached the very low value of about \$2,500,000. It requires considerable time for a coffee grove to recuperate after being so severely damaged. The crop for 1901 reached nearly its normal amount, but will be much reduced in value because of the very low price at which it will have to be placed upon the market. In the years preceding 1898 the island found a market in France, Spain, Italy, and various other European countries for the greater part of its coffee, at prices ranging from 20 to 35 cents per pound. During the present year, however, the price received for Porto Rican coffee averages about 12 cents, or less than half the average price for ten years preceding 1898.

AGRICULTURAL CONDITIONS.

Agriculture in Porto Rico is primitive and backward. Little is known relating to the growing of any crops other than coffee, sugar, and tobacco, and the cultural methods of these three are very poor. There

is a dearth of skilled labor and an excess of the poorest and most ignorant kind. Improved implements of any sort are rarely used. The roads for getting produce to the local markets and to the seaports are so few that the cost of transportation often exceeds the market value. The home market is limited and the facilities for export transportation are not suitable for perishable produce. Better transportation is imperative. There is need of the introduction of improved machinery as well as of seeds, plants, and animals to take the place of those that are now so deteriorated through lack of selection and proper care that they are valueless. There is a good field for the development of some of the tropical fruits by selection, breeding, and better methods of management and their introduction into good markets. Last, but not least, the people should be taught and encouraged to adopt improved methods and fit themselves for a more intelligent management of agricultural affairs. There is great need for capital for the proper development of the island's resources and there is need for American enterprise to push things. It must be borne in mind that the great mass of the people are very poor and the island is therefore not a desirable place for an American of small means to go unless he knows beforehand that he will be profitably employed. There are many more people there waiting for employment than places to be filled. Capital, however, if judiciously invested and properly managed should give sure returns at a good rate of interest. Under the descriptions and conditions of crops brief suggestions of the possible opportunities for investments in each will be given.

According to a recent estimate the agricultural lands are grouped as follows:

Acreage of cultivated and uncultivated lands in Porto Rico.

	1899-1900.	1900-1901.
	<i>Acres.</i>	<i>Acres.</i>
Lands planted with—		
Sugar cane.....	80,034	82,678
Coffee.....	180,289	166,164
Tobacco.....	15,324	13,704
Miscellaneous.....	104,059	201,815
Pasturage.....	1,206,593	1,203,206
Woodland.....	318,897	165,671
Brush lands.....	25,659	
Not cultivated.....		138,348
Total.....	1,932,855	1,971,586

The above figures are taken from the reports of Mr. Juan B. Rodriguez, in his reports to the secretary of the interior for Porto Rico. The most striking change from 1900 to 1901 is the increase in acreage of miscellaneous crops of nearly 100 per cent. The percentage of lands under actual cultivation for the first year was only 18.9 and for the last year 23.5.

Areas cultivated in principal crops in acres—from the census of 1899.

Crop.	Acres.	Crop.	Acres.
Coffee.....	197,031	Malangas.....	12,256
Sugar.....	72,146	Rice.....	8,667
Bananas.....	69,380	Tobacco.....	5,963
Sweet potatoes.....	37,109	Cocoanuts.....	5,447
Corn.....	18,093	Yams.....	2,098

These figures differ quite materially from those of Mr. Rodriguez in the above table, but it must be borne in mind that the census was taken in November and December, 1899, while Mr. Rodriguez's figures are probably for the fiscal year ended June 30, 1900. The marked difference in acreage of tobacco, for example, is probably due to the fact that at the time the census was taken the tobacco for the fiscal year had not been planted, and the acreage as reported was probably for the crop that had been harvested several months earlier.

COFFEE.

Coffee is by far the most important crop of the island, and as an article of export has exceeded in value that of all other exports combined. The cultivation of coffee was introduced into Porto Rico by emigrants from the island of Haiti. In 1768 the King issued a royal cedula giving to Porto Rico a monopoly of the cultivation of coffee, and relieving or exempting the growers from the payment of any taxes for a period of five years. In 1770 the island produced 7,280 pounds, and in 1776, 11,262 pounds. In 1850, or three-fourths of a century later, the yield had increased a hundredfold, or to 11,783,684 pounds. The lack of suitable market and the time required for coffee to come into full bearing offered very little inducement for planters to extend its cultivation, and progress was consequently slow. In 1876 the United States opened its ports to free coffee. This proved a marked stimulus to the Porto Rican grower, and for a short time large shipments were made to the States. Very little attention was paid to quality, and as the island could not compete with Brazil in price, the market remained for the latter and Porto Rico found a better market in southern Europe.

Quantity and value of coffee exported from Porto Rico during each calendar year from 1887 to 1896, inclusive.

Calendar year.	Quantity (pounds).	Values.	Calendar year.	Quantity (pounds).	Values.
1887.....	27,670,000	\$3,391,000	1892.....	47,354,000	\$9,122,000
1888.....	51,202,000	6,275,000	1893.....	49,250,000	11,205,000
1889.....	37,238,000	4,564,000	1894.....	50,507,000	11,496,000
1890.....	43,909,000	5,382,000	1895.....	40,244,000	9,160,000
1891.....	41,725,000	5,112,000	1896.....	58,780,000	13,379,000
Annual average, 1887-1891.....	40,349,000	4,945,000	Annual average, 1892-1896.....	49,279,000	10,872,000

The above table shows a gradual growth in the exportation of coffee for the ten years ended in 1896. In this year it reached a maximum of over 58,000,000 pounds, with a value of over thirteen and a third million dollars, or a mean average price of nearly 23 cents per pound. This is a very satisfactory showing and in marked contrast to the present much-depressed condition, which has resulted from a combination of the following circumstances: (1) The loss of the European market largely through the war with Spain and the resulting transfer of the island to the United States; (2) the great damage to the plantations by the cyclone of August, 1899, and the time and capital required to recover from it; and (3) the very crude method used in the production of coffee. By the introduction of modern methods in the cultivation of coffee and the adoption of good business methods in introducing it into the market of the States on its merit there should be a good future for coffee.

The present methods of cultivation are very primitive and consist chiefly of transplanting volunteer trees from old groves to new fields and providing shade by growing trees suited to the purpose. It is common to plant shade trees several years in advance of setting the young coffee trees, and if the shade from them is not sufficient when the coffee tree is to be set temporary shade is provided by planting bananas. The young trees for planting the new groves are volunteer plants which spring from the berries that fall to the ground and are not gathered. These volunteer trees thus represent no selection. They usually grow in dense shade, and are consequently spindling and lacking in the form and vigor which is desirable for nursery stock. These trees, usually about a foot in height, are set in the new fields at irregular intervals, varying from 5 to 10 feet, and without any regard for rows or symmetry. Two trees are usually set in each hole, so that if one perishes another will remain. If both grow, they are allowed to remain, each interfering with the proper development of the other. While the trees are small the soil is occasionally stirred about them with a machete and the weeds are cut down with this same instrument.

No attempt is made to control the form of the tree by pruning or to protect it from the ravages of insects and diseases by spraying or by other methods. The shade is often too dense, and no effort is made to reduce it by pruning the shade trees. This neglect results in tall, spindling, shapeless coffee trees that require from five to seven years to come into bearing. After the trees begin to bear volunteer trees spring up, many of which are allowed to grow until the groves often become a dense thicket, through which the coffee pickers pass with difficulty. Under these conditions the fruit is largely borne on the tops of the trees, which makes the gathering slow and laborious.

As a rule, too much shade is provided and it is a question if the

coffee could not be grown without shade. The trees best suited for the shading of coffee are recognized as the "Guamá, Guava, Moca, Hucare, and banana." The first two are considered superior to the others, a fact which may be attributed to their being leguminous trees and possibly furnishing nitrogen for use of the coffee trees.

Coffee is grown chiefly in the interior of the island on the mountain slopes and is confined largely to the west half of the island. The most prominent municipal coffee districts are Utuado, Las Marias, Maricao, Lares, Ciales, Adjuntas, Mayaguez, San Sebastian, Ponce, and Yauco, in the order named. These ten districts produce 60 per cent of all the coffee grown in the island. The Utuado district leads the list with about 17,000 acres and is nearly the center of the coffee area.

The soil conditions vary much from locality to locality, and even on one plantation wide differences often occur. Coffee is very susceptible to soil changes, and many large estates are in part only suited to the growing of coffee. This relation between soil and crop does not seem to have been well understood by the native planter, for many acres have been planted on lands that are poorly adapted to the growing of coffee solely because of the character of the soil. The best coffee is always found on soils of heavy texture, i. e., soils that are classed as clay loams or clay, and which continue heavy in texture to a depth of 3 or more feet. If the depth of heavy soil is 2 feet or less and is underlaid by stone, sand, or gravel the coffee becomes poorer, as the underlying coarse material comes nearer the surface. Sand or sandy loam never produces good coffee except it be nearly level and well fertilized. While the red clays are considered the best coffee lands, it is doubtful if the color has any bearing on their quality. The red indicates the presence of plenty of iron, which may be an important factor, but it is more likely to be the coincidence of the red color usually accompanying the heavy clays. The coral limestone along the north border of the mountains breaks down into a fertile soil well suited to bananas, citrus fruits, and minor crops, and when very fertile may produce good coffee, but such soils are not to be compared with the heavy red soils further inland. The dark-colored soils on the southern slope, especially those about Adjuntas and Yauco, are also excellent for coffee. It is claimed by some that the black soils produce greater yields than the red, but that the latter produces coffee of the best quality and trees of the longest life.

The coffee tree in Porto Rico is said to attain its maximum producing power at the age of about twelve years and continues in good bearing condition to the age of fifty years. Trees are reported at the age of eighty-two years only 2 to 3 inches in diameter, and in good bearing condition. Wherever the soil conditions are not favorable to the coffee trees they are badly infested by a leaf miner and affected by scale insects and fungus diseases.

The cyclone of August 8, 1899, wrought great damage to the coffee plantations. The terrific wind broke the large shade trees, which, falling across the smaller coffee trees, not only bore them to the ground but obstructed passage through the plantations and allowed the sun to beat down on foliage that had previously been very much shaded. The wind swayed the trees so furiously that many of their roots were either loosened or broken, while the deluge of water swept the surface and carried seaward vast amounts of organic matter, loose soil, and fertility, thus greatly depleting the soil. In places the deluge was so great that considerable areas of land, accompanied by the shade and coffee trees, slid from the mountain sides to the bottoms of the valleys, leaving only the bare rocks of the mountains. The sun poured into the groves onto slender trees that had always been accustomed to shade, and the effect on the foliage, the trunks, and the ground combined was very disastrous. As a result, the plantations, probably always showing much variation, are more spotted than formerly. What were formerly good trees are now, in many cases, barely alive, having only a few scattering leaves on their tops and bearing no fruit. The great damage caused the coffee lands through the violent washing and depletion of the soil has in many instances been a gain to the sugar planter. His fields are now more fertile than for years preceding the cyclone, as a result of the rich deposits of sediment which they received. The mean yield of coffee in Porto Rico is abnormally low, being about 2 quintals a cuerda, i. e., 200 pounds per acre. By the adoption of modern methods of planting and cultivation there is scarcely a doubt but that the yield can be doubled and it can probably be increased by five times, or 1,000 pounds per acre. On a basis of 1,000 pounds per acre, even at only 10 cents per pound, coffee growing should be very remunerative.

SUGGESTIONS FOR IMPROVEMENT.

Improvement of the coffee plantations will be attempted along two lines: First, the improvement of the old groves by reducing the shade, thinning and pruning the trees, and giving cultivation and fertilization; second, the adoption of a more rational system in the planting and care of young groves. That too much shade is used now is shown by the fact that the best and most productive coffee trees occur about the margin of the plantations or in open spaces where the shade is incomplete and where, for a portion of the day at least, the coffee trees enjoy the full sunlight.

The statement that coffee can probably be successfully grown in Porto Rico without shade does not mean that the shade can be all removed from the present plantations, nor that the young trees can be transferred from the shade of the old groves to the full sunlight of

new fields without practically all perishing. Such a radical change would result disastrously to the plants.

In reference to new plantations the first step should be the selection of seed with reference to the improvement of the trees. Seed should be selected from the vigorous, best-formed and most productive trees. It should then be planted in suitable seed beds provided with artificial shade which can be removed by degrees. As the young trees grow, the shade should be gradually removed as they seem able to adapt themselves to the sunlight. If the shade can be all removed without injury to the young trees they can certainly be transferred to the fields without great loss and will probably continue growing without shade. Only the vigorous and well-formed plants should be planted, and all should be planted on soils well adapted to the production of coffee. Planting should be made in conformity to some system. The trees should be set in rows, at least one way, and at a uniform distance of about 7 feet apart. If the land is steep a small terrace should be made about the tree. As good and thorough cultivation should be given as is consistent with the slope of the ground and the character of the rainfall. A high state of cultivation might permit washing of the soil and consequent damage by loss of fertility and would be worse than no cultivation. The trees should be pruned to some system in conformity to its nature of growth and the convenience of gathering the coffee. If there is a tendency to grow too tall they should be topped.

Such a system should not only make a much finer appearing plantation than the old haphazard way of doing, but the superior trees should reach a bearing age earlier and produce far more than under the old method. On the above basis an acre would contain 889 trees, which at the low estimated yield of $1\frac{1}{4}$ pounds of coffee for each, would give 1,111 pounds per acre. Such a yield in comparison with the present one of 200 pounds per acre would certainly be very satisfactory and justify the additional expenses involved by the improved method.

The above method is being tested by Mr. J. W. Van Leenhoff, of Isalina, in cooperation with the agricultural experiment station. While the indications are thus far good, no definite assertions can be made as to the success or failure of the method until the trees approach a bearing age.

If the ground needs a covering in order to prevent its washing, it is the purpose to sow some low-growing leguminous crop, keeping it cut away from the immediate vicinity of the young trees and using the cuttings for market. If the crop can not be economically used for forage it should be allowed to decay on the ground, thus increasing its fertility.

MARKET.

Low prices for coffee are responsible in part for the present depression to the industry in Porto Rico. Every effort should be made to introduce the coffee into the States on its merit under the name of "Porto Rico." The coffee is of excellent quality and when known it will undoubtedly replace a part of the fancy trade that is now supplied by Mocha and Java. This can be brought about by organization and a systematic handling of the product.

SUGAR.

The production of sugar in Porto Rico is at present in a very flourishing condition, and considerable capital from the States is being invested in lands and in the construction of large "centrals." It is estimated that the amount of export sugar for 1901 will reach 100,000 tons.

The area of land suited for the production of sugar is capable of being more than doubled, and by the introduction of better machinery for the extraction of the sugar and better methods of cultivation of the cane, it is safe to say that the output of sugar by Porto Rico will reach a maximum of about 300,000 tons annually.

*Quantity and value of sugar exported from Porto Rico during each calendar year from 1887 to 1896, inclusive. **

Calendar year.	Quantity (pounds).	Value.	Calendar year.	Quantity (pounds).	Value.
1887.....	178, 116, 000	\$5, 068, 000	1892.....	148, 364, 000	\$3, 897, 000
1888.....	136, 658, 000	3, 888, 000	1893.....	94, 992, 000	2, 481, 000
1889.....	140, 236, 000	3, 990, 000	1894.....	106, 724, 000	3, 170, 000
1890.....	128, 289, 000	3, 650, 000	1895.....	132, 147, 000	3, 906, 000
1891.....	106, 029, 000	3, 017, 000	1896.....	122, 946, 000	3, 604, 000
Annual average 1887-1891.....	137, 866, 000	3, 923, 000	Annual average 1892-1896.....	121, 035, 000	3, 484, 000

*Table from Bulletin 13, Section of Foreign Markets, U. S. Dept. of Agriculture.

The above table shows that the heaviest exportation of sugar occurred in 1887; that it steadily decreased for a number of years thereafter, reaching a minimum of about 95,000,000 pounds in 1893, with a value of less than half that of the year 1887. The average exportations for the first five years are considerably greater than for the last five. In addition to sugar, molasses has also been exported to an average value of about \$500,000 annually. At the present writing there are many old sugar estates that have been abandoned, the lands turned out to pasture, and the buildings in a state of ruins. These estates were mostly limited in extent and equipped with old machinery, which was not at all suited to carry on high-grade manufacturing of sugar. The lands were often too wet to give good results, and this, together with



FIG. 1. PORTO RICO STATION. HARVESTING SUGAR CANE.



FIG. 2. PORTO RICO STATION. HARVESTING SUGAR CANE.

the poor equipment, has given rise to their abandonment. With better machinery and adequate land drainage, all of these abandoned estates will undoubtedly be again planted to sugar in the course of a few years. The abandonment of these estates has undoubtedly caused an increased activity in the production of live stock, and we find, therefore, that the value of live-stock exports has increased from \$142,000 in 1895 to \$852,000 for the year 1899.

The great damage caused to the coffee lands by the cyclone of August, 1899, through the excessive washing and consequent depletion of the soil fertility, was a great benefit to the sugar lands. A considerable part of the sediment carried by the deluge of water which spread over and inundated the most of the low lands was deposited there, often to a foot in depth. This rich deposit has in a great measure restored the sugar lands to their former fertility.

Notwithstanding the prosperous condition of the sugar business and the fact that its management is in a more advanced stage than that of almost any other product of the island, there is still room for great improvement in both its cultural and manufacturing aspect. (See Pl. XXXV, figs. 1 and 2.) The cane fields are usually well planted and kept comparatively free of weeds, but the cost of growing an acre of cane laid down at the mill, \$40, is much greater than it should be. This price is, of course, for the first year, and includes the cost of plowing, planting, and cultivation as well as that of harvesting. It is a common practice to grow several ratoon crops, and these cost much less for production, because no plowing and planting are required. The yield from the ratoon crop, however, is less than for the first crop, and grows less and less each year. It is not uncommon to allow fields to produce four or five consecutive ratoon crops, and instances are recorded where as many as twenty have been grown. A reduction in the cost of planting and harvesting the first crop will tend to reduce the number of ratoon crops, and thereby increase the average yield. The number of ratoon crops allowable depends entirely upon the relative profit to be derived from them.

The drainage of the cane lands is often insufficient to give good results, and when good drainage is provided it is in the form of open ditches, which are expensive to keep in repair. A more rational, satisfactory, efficient, and, in the long run, cheaper method would be to underdrain the cane lands by the use of tile drains. Tile drainage once well installed would last for practically all time to come. It would do away with the annual cost for reconstruction and repairs of ditches, and, besides being more efficient in restoring to cultivation the areas formerly occupied by ditches, it would also facilitate the use of more improved machinery for cultivation. The planting season for cane extends over a considerable portion of the year. The large plant-

ing, or "grain culture" as it is called, takes place in October and the canes are harvested fifteen months later. Plantings are also made in February, March, April, and May, the canes being cut a year later. The harvesting and grinding season continues from January to June, a period of about five months. The seed cane planted for the "small culture" in February to May consists of the top two or three joints cut from the cane that is being harvested for sugar. The cane at this season of the year is said to be so ripe and dry that only these top joints are capable of producing new plants. The seed for the "grain culture" is obtained from the early plantings of the year, and in this case the whole cane is used for seed, it being so green that all joints will produce new plants.

No efforts are made toward improving the quality of cane by selection. Presumably, there are as great possibilities in improving cane as has been realized in the case of sugar beets during the past ten or fifteen years.

Two systems of planting are in vogue. On the north side of the island, where the rainfall is abundant, irrigation is not practiced and drainage is essential. There the land is plowed into ridges about 8 feet wide with deep furrows between. On each ridge two rows of cane are planted. Large, shallow holes, about 6 inches deep and 15 inches square, are made at intervals of about $2\frac{1}{2}$ feet, and the pieces of seed cane placed in the bottom of them and covered with soil to the depth of about 1 inch. Usually the lower end of the cane is covered deeper and the upper end frequently not covered at all. After planting all further cultivation is done with the hoe. The weeds are cut from between the rows and hills and pulled from among the young plants. The soil is gradually worked around the young plants at each hoeing until the holes are filled nearly level with the remainder of the ridges. The number of hoeings required to keep the field free from weeds varies somewhat, but is seldom less than four. The canes stool out, and in about five months so completely shade the ground that weeds will no longer grow and no further attention is required until harvest time.

On the south side of the island, where the rainfall is scanty and where irrigation is imperative for the successful growing of cane, the land is plowed level. Furrows about 6 inches deep are run at intervals of about 4 feet, in which the cane is planted. The covering of the cane is shallow, the same as in the former method, and the cultivation largely done by hand. In irrigating the water is passed down these furrows, thus coming first in contact with the plants. This system of planting seems superior to the one practiced on the north side of the island. The furrows in which the canes are planted are more cheaply made than are the holes used for the same purpose, which are made by hand. The absence of surface ditches and the level surface of

the ground facilitates the use of machinery in cultivation, although but little is used, even on the south side of the island.

It is recommended that for all lands needing drainage it be supplied in the form of underground drains; that the land be plowed deeply with good plows and at such time that it is not too wet; that the cane be planted as a continuous row in furrows, and that a large part of the cultivation be done by using horse machinery and giving much the same cultivation that is used in the case of corn in the Mississippi Valley. By replacing much of the hand labor with improved machinery the cost of growing cane should be much reduced. In this connection careful attention should be given to the selection of healthy seed and of canes having a high sugar content.

In order to maintain good physical and fertile conditions in the cane-growing soils they should receive judicious management. At present the lands are often plowed and hoed when too wet, and much injury done to its physical properties. Few crops take more from the soil in the way of fertility, especially of nitrogen, than a good yield of sugar cane, and much care should be exercised to restore this loss. If necessary the lands should be given periods of rest and be planted to cowpeas or some good, suitable leguminous crop that can be plowed under, thus restoring the loss of nitrogen. The application of barnyard manure and of commercial fertilizers may be profitable if they can be secured at a cost not too great.

MANUFACTURE OF SUGAR.

For the most part the methods of manufacturing sugar in Porto Rico have been crude and wasteful. The mills are usually small and lacking in machinery of recent design and sufficient strength to extract all of the juice from the cane. The juice is usually evaporated by the open-pan system, and besides requiring more time and fuel than the vacuum system it produces only a low grade of muscovada sugar. The imperfect removal of the juice leaves the bagasse too wet to be at once burned, therefore it must be hauled away from the mill and spread out to dry, after which it is placed in sheds in order to keep it dry for fuel. Where efficient machinery is employed the juice is so completely removed that the bagasse can be at once burned. In the latter case the bagasse leaves the second press and goes directly to the furnace on a carrier, so that there is no handling of this material required. The bagasse furnishes sufficient fuel to run the entire plant.

The need of large "centrals" with improved machinery has been realized, and a general movement is on foot to organize the districts, do away with the old mills and secure new ones, by which more and better sugar can be obtained from the cane at a less cost.

TOBACCO.

Tobacco has for many years ranked third among the export crops of the island, and at the same time has supplied a comparatively large home demand. It is the exception to find a Porto Rican man who does not smoke, and many of the women, especially of the middle and lower classes, also enjoy the cigarette and cigar. The manufacture of tobacco into cigars and cigarettes is probably of far greater magnitude than the manufacture of any other single commodity on the island.

*Quantity and value of tobacco exported from Porto Rico during each calendar year from 1887 to 1896, inclusive.**

Calendar year.	Quantity (pounds).	Value.	Calendar year.	Quantity (pounds).	Value.
1887.....	7,633,000	\$1,089,000	1892.....	4,207,000	\$737,000
1888.....	3,347,000	478,000	1893.....	4,208,000	774,000
1889.....	7,736,000	1,104,000	1894.....	3,370,000	619,000
1890.....	3,984,000	569,000	1895.....	3,665,000	674,000
1891.....	5,287,000	755,000	1896.....	2,220,000	408,000
Annual average, 1887-1891.....	5,597,000	799,000	Annual average, 1892-1896.....	3,534,000	642,000

*From Bulletin 13, Section of Foreign Markets.

The above figures for the ten years 1887-1896 show a decline in the exportation of tobacco. Previously the manufactured tobacco was practically all consumed at home, but at present there is quite an export trade with the States in cigars and cigarettes, and a larger percentage of the total product is now manufactured than formerly. While the annual amount of tobacco exported has declined, the price per pound has increased from an average of about 14 cents in 1887 to 18.4 cents in 1896.

The crops for 1900 and 1901 are in large part still on hand, a fact which tends to keep the price down and gives no incentive for increasing the acreage. The 1900 crop consisted of about 15,000 acres, which yielded only 300 to 600 pounds per acre. While tobacco of good quality is grown, yet there is a lack of skill in curing and fermenting it, and the people are in special need of instruction along these lines. The lands recognized as being best for tobacco are largely along the Rio La Plata. Of the tobacco districts, Comerio leads with an area of 2,000 acres, Camuy follows with an area of 1,039, and other important districts are Cidra, Naranjita, Yauco, Isabela, Aibonito, and Caguas, in the order named.

The preparation of the land for the seed beds usually takes place in August and September, and the seeds are planted from a month to six weeks later. The plants are transplanted to the fields in December and January, and require eighty to ninety days to come to maturity. The first crop of tobacco is therefore harvested in March or April. Suckers at once start from old stumps, and in from four to six weeks

another crop is ready to harvest. This second crop is much inferior to the first one, and is largely used for filler purposes. In many instances even a third crop is harvested, but it is very poor in quality and of little value except for cigarettes.

While some tobacco of excellent quality has been grown in Porto Rico, it is not known in United States trade. Formerly much of this class of tobacco was exported to Cuba, and part of it was undoubtedly shipped from there to the States.

Tobacco is a quick crop and one which should play an important part in giving early financial relief to the people of the island. By the introduction of improved methods it should offer good opportunities for investments and bring prompt and large returns on the capital invested.

The United States Department of Agriculture proposes to send two tobacco experts to the island to spend the greater portion of the next fiscal year in investigating the tobacco industry. They will begin with the planting of the crop and conduct experiments relating to all phases of the subject, from the beginning to the finish. These experiments will deal with the curing and fermenting of the product as well as the growing. This is an important work for the people of the island, and will begin with the next crop season.

CITRUS FRUITS.

While coffee, sugar, and tobacco are practically the only crops of export, many others are grown in a small way for home consumption. Many of these minor crops are not grown in sufficient quantities to supply the home market. Rice and potatoes, which are imported in large quantities, might well and profitably be grown to a greater extent at home. There is also great need of more diversity in the export crops. With so few crops for exportation a failure in one means a great reduction in the income of the people. The injury to the coffee industry by the cyclone of August 8, 1899, is a striking example, and illustrates the need of other export crops. The great reduction in the coffee receipts has caused untold suffering. Thousands of poor people who formerly were employed on the coffee plantations were thrown out of employment, there being nothing else for them to do. Many were supported by the coffee planters in order to tide them over until the groves should again come into bearing.

The production of citrus fruits will undoubtedly make a desirable and important addition to the export crops. Oranges, limes, and lemons are grown in a small way in nearly all parts of the island, and indicate that by the introduction of improved methods there will be a very good future for this branch of fruit culture. At present there are no groves planted with regularity, pruned, and cultivated. The trees are planted, a few here and there, about the buildings of the

plantations, and are given no particular attention. They are seedlings, and in the case of oranges represent all grades and conditions from the small sour fruits with many seeds and an abundance of rag to the large sweet fruit with little rag and few seeds. The range is from worthless fruit to that which is of excellent quality, but the latter occurs in very limited quantity. As a rule the oranges contain too much rag and too many seeds, and it is difficult to get together a uniform lot of any considerable quantity for shipment.

Two kinds of oranges are grown, the sour and the sweet. The experience thus far gained by those who are starting in the orange-growing business is that the sour one forms the best stock on which to graft improved varieties.

The growing of oranges in Porto Rico by improved methods is in the experimental stage, and it will require several years of systematic investigation to ascertain just what are the best varieties to use in planting, what are the best stocks on which to graft, how and when is the best time and methods to graft, what type of soil is best adapted to growing oranges, and many other allied questions.

If possible to do so, it would seem desirable to grow an orange that will mature earlier than do those of Florida and California, thus getting them into the early market when the price is good. Better transportation facilities are needed, but such will undoubtedly be supplied when the demand is sufficient to justify it.

There are several fungus diseases and scale insects which attack the orange trees, and it will be advisable for all that are importing stock for whatever purpose to guard against the introduction of diseases or insects not already on the island. Probably a law should be enacted providing for the inspection of all nursery stock introduced into the island, and requiring all infected material to be thoroughly fumigated. In the Tropics, where the breeding seasons are not checked by cold weather, both diseases and insect pests take on the most virulent form and especial care is required to keep them in check.

THE AGUACATE, OR ALLIGATOR PEAR.

This valuable fruit occurs in all parts of the island and is quite an important fruit for home consumption. During its season it can be bought in the markets at from 1 to 3 cents each while in the States it often sells at 50 to 75 cents per fruit. The trees are large and in a general way resemble the pear trees of the States. They occur scattered about here and there, growing in almost a wild state with no cultivation, pruning, or care. The fruits are large and pear-shaped, usually weighing from a pound to a pound and a half. When ripe the green skin, about one-eighth inch in thickness, separates freely from the fleshy pulp, which is the edible part. A large nut or seed

FIG. 1. Part of Rain Station at GARDENING COVINGTONS.



FIG. 2. Part of Rain Station at GARDENING COVINGTONS.



in the interior also separates freely when the fruit is cut in half. The fruit contains about 10 per cent of oil, has a nutty flavor, and is quite nutritious. Americans are usually very fond of it. It is eaten raw in much the same way as a cantaloupe or is used in the form of a salad with a dressing.

With the present facilities it is impossible to ship the aguacate to the States without a large loss, but with better shipping facilities and a knowledge of the shipping possibilities of the fruit there should be a good future in growing aguacates for export to the States.

MANGOES.

This fruit, like the aguacate, occurs in nearly all parts of the island, but is more common and cheaper. The trees are large and sturdy, giving a very dense shade. The fruits ripen during the months of May, June, and July, and are eagerly eaten by the natives. They are kidney shaped, about the size of an apple, and when ripe have a yellow or golden color, often with a rose-colored cheek. The fruits vary much in size and quality and are susceptible of great improvement. They have a large seed or nut and the pulp surrounding it is rich and juicy. It has a flavor of turpentine, and owing to the large amount of fiber which some of them contain, some one has humorously described it as resembling a ball of yarn soaked in turpentine. There is a good opportunity of improving the quality of this fruit and creating for it a good demand in the States.

BANANAS.

Bananas grow almost spontaneously in all parts of the island but are not exported. (Pl. XXXVI, fig 1.) There are several varieties grown and they form an important part of the food of the natives. Several kinds of what are known as plantains are cooked green and used by the natives. They take the place of bread in a large measure. The red banana, the ladies' finger, the peach, and the ordinary banana of our commerce, are common and used by many. They sell in the interior very cheaply, often as low as a cent per dozen. Many bananas are grown as coffee shade, and in such localities the fruit often goes to waste or is used as pig feed. For its best development the banana requires a sheltered locality and moist atmosphere. Where strong winds prevail the leaves become riddled and fail to perform their functions. The best bananas in the island are in the interior among the mountains and in other sheltered localities.

There is no reason why the banana should not be greatly improved by selection and proper cultivation, and be made an important factor among the export tropical fruits. (Plate XXXVII, fig. 2.)

GUAVA.

The guava grows wild and often takes possession of the pastures. It is manufactured into jelly and a paste, both of superior quality and flavor, which command good prices in the States. The guava is a bush, and the fruits ripen in August, September, and October. They are relished by the cattle, and the numerous seeds being small and hard, are not digested but are scattered about the fields and thus distributed.

This fruit, by selection, pruning, and cultivation, can undoubtedly be greatly improved in quality and productivity. It is one of the fruits for which there is already an established demand, and one which can be manufactured at home, thus giving employment to many, and at the same time not requiring any transportation facilities other than those now in operation.

PINEAPPLES.

Pineapples of fine size and excellent quality are grown in many parts of the island. They do best on the sandy lands about the coast or on the stony hill lands of the interior. They require good drainage.

There are three principal varieties now grown: "Pan de azucar" (literally, sugar loaf), "Carbezona" or "Porto Rican," and "smooth cayenne." The first named is the sweetest but usually contains much fiber, the second has a white meat, is subacid, and of pleasant flavor. It is large and comparatively free from fiber. The third was probably introduced from Florida but is not much grown.

Pineapples are but little exported, but with proper facilities might well become an important export crop. By the introduction of the right sorts for canning purposes a cannery might be started and do a good and profitable business.

COCOANUTS.

Cocoanut palms grow best on the coral sands bordering the coast, but often occur in the interior. (Pl. XXXVI, fig. 2.) Those in the interior, however, do not bear so early nor so well. The coast conditions, which combine a level, wet, sandy soil with the salt-laden atmosphere, seem to be the typical conditions for the production of nuts. The trees are easily grown, and require but little care in the way of cultivation. They begin to bear in from 5 to 7 years, and at 10 or 12 years of age often produce as many as 200 nuts per tree annually. (Pl. XXXVII, fig. 1.) The nuts are much used for home consumption by the natives for "cocoa de agua," and are exported to the valuation of about \$10,000 annually. The cocoanut lands are limited in extent, and might be used for the combined purpose of growing pineapples and nuts.



FIG. 1. PORTO RICO STATION—COCOANUT GROVE.



FIG. 2.—PORTO RICO STATION—MARKETING BANANAS.

CACAO.

The requirements of cacao are so similar to those of coffee that it should do well on the island. Plants of it are found here and there, and, as a rule, are doing well. It may become an import crop in the course of a few years.

FIBER PLANTS.

The two principal fiber plants are the maguey and the emajugu. The former is a species of agave, or century plant, and the leaves often attain a length of 8 or more feet. When blooming it sends up a flower stalk to a height of 30 feet or more. The fiber is much used in the making of rope, belts, hammocks, etc. The latter is a shrub and the fiber part is the inner portion of the bark. It is much used for making coarse ropes and baskets. There are other fiber plants on the island which are not much used, and it seems very likely that the abaca, a species of banana from which the manila hemp is obtained, would thrive and become a profitable crop for the island.

Twenty or more years ago some cotton was grown on the island, and remnants of it still remain in the form of occasional small cotton trees. During the past year a certain cotton company in the States has been experimenting with cotton in various parts of the island. They have planted every month in the year and have arrived at favorable conclusions, but have not made public the results of their investigation. My personal observation leads me to believe that the best season to plant is June or July, thus having the cotton mature in the early part of the dry season, which usually begins with December. The beginning of the dry season, however, is rather uncertain, and may be delayed by weeks or even months.

There are many other plants of economic value, some of which are native and others which might be introduced that would be valuable crops for the people of the island, but space will not be taken for further mention of crops.

MINOR CROPS.

Minor crops, such as rice, corn, potatoes, yams, beans, peas, tomatoes, melons, and a variety of other vegetables, are grown in a limited way for home consumption. There is room for great improvement with practically all of these crops. Just where the trouble now lies is difficult to say. Little seems to be known in regard to the time and manner of planting. In the markets one finds quite a variety in the line of vegetables, but practically all are of very inferior quality. Tomatoes are very small and wrinkly, and in the States would be thrown away. Potatoes grown here are small, and must be imported

to the value of about \$400,000 annually in order to supply home needs. Onions are also imported, as indeed are quite a variety of vegetables. Rice is the heaviest import, and amounts to considerably more than \$1,000,000 annually. Many small patches of rice are grown in the interior of the island on the hillsides, but none is grown on the lowlands about the coast. There is considerable low, swampy land about the coast that might be devoted to the growing of lowland rice. The time of seeding and manner of cultivating would, of course, have to be determined by experimenting, but much knowledge could be obtained from Louisiana, where rice is grown on an extensive scale. Many of the methods used there would no doubt be applicable to Porto Rico.

Corn is grown to a considerable extent, and is used as food for both man and beast. The variety grown is a smooth flint, very similar to that grown in the New England States. It is shelled and ground, as a rule, by hand, although a few use hand shellers and grinding mills.

Wheat, barley, and oats are practically unknown, so that corn forms the chief grain that is fed to animals. Very few of the horses are fed any grain, and practically no grain is given to the cattle or work oxen.

FORESTRY.

It is said that Porto Rico was once covered with a beautiful virgin forest. Only a few remnants of such forest now remain to indicate what were the former conditions. It would seem advisable to protect and preserve these remnants, and in some instances to plant new forests.

AGRICULTURAL MACHINERY.

Very little agricultural machinery is used. In the cane fields plows, harrows, carts, hoes, spades, and machetes constitute nearly the complete list, while in the coffee district the hoe and machete are about the only implement used. In the latter case the steepness of the hills prohibits the use of much horse machinery, but in the cane fields modern plows, harrows, and cultivators can and should be used.

LIVE STOCK.

The live stock of Porto Rico consists mainly of cattle and horses, together with a small number of mules, asses, swine, sheep, and goats. Following is the total number of each class as ascertained by the census of 1899: Cattle, 260,125; horses, 58,664; mules, 6,985; asses, 1,085; swine, 66,180; goats, 15,991; sheep, 6,363; and fowls, 265,499.

Of the total number of cattle, 28 per cent are given as milch cows and 22 per cent as work oxen, the remainder being classed as calves, steers, bulls, young bulls, heifers, and yearlings. Of the various districts Bayamon leads in all classes of cattle except oxen, in which Ponce

excels. Ponce has more oxen, mules, and asses than any other district because of the demand for them as work animals on the large sugar estates.

The horses of Porto Rico are very small, and, as a rule, are poorly cared for and driven or ridden with very poor judgment. There are some exceptions, however, with regards the treatment of horses, and I have seen some very fine and spirited animals that were kept in the pink of condition. The feed of the horses consists almost entirely of cut grass, it being very exceptional to find them fed on grain. Such bulky food necessarily distends the bowels and unfits a horse for rapid traveling. Notwithstanding the fact, however, the native Porto Rican will harness his team to the carriage when their stomachs are full, and start at once on his journey at a full gallop. Under such circumstances the horses are winded at the end of the first kilometer, and before the second one is completed they are covered with sweat and lather, and wholly unfit to continue at anything but a slow gait unless given a rest. They are forced to continue, however, and complete the journey under continual lashing by the driver. When long journeys are to be taken frequent relays are made, usually at each 10 to 15 kilometers.

Although small the better horses are of good form, clean of limb, and apparently have a strain of good blood. With proper care as to feed and methods of driving these little horses are capable of rendering good service. As saddle-horses they are particularly good and easy-gaited and as hill climbers they are unexcelled and very sure-footed.

There is no marked mortality among the horses due to disease. The common diseases due to mistreatment, such as colic, lung fever, etc., are met with, but the worst, most revolting, and dangerous disease is glanders. Glanders is present in all parts of the island, and drastic measures should be taken at once to stamp it out. A skin disease, probably a form of mange, is not uncommon. Comparatively speaking, the insects that trouble the horses are few. Ticks are quite numerous, but there are practically no flies to bother.

The cattle of the island are better than one would expect to find. As work oxen they are excellent. Bullocks weighing 12 to 13 hundredweight, with powerful necks and good forms are not uncommon. Steers range on the luxuriant pastures of Guinea grass and "malojillo" grass and become fat enough for market without the addition of any other feed. Besides supplying the home demand for fresh beef the exportations of live cattle as beef and work cattle amount at present to more than half a million dollars annually. The chief market for the cattle is Cuba. In milking qualities the cattle fall far below their standard for beef and for work. The flow of milk is small and the quality poor as regards its fat content. It is quite the custom to milk the cows while the calf is sucking; otherwise it is thought they will

give but little and soon go dry. Milk sells in the towns and cities from 6 to 9 cents per quart. The more advanced dairyman delivers the milk in cans hauled on a spring cart, while others carry it to market in small cans on the backs of horses. Still others drive the cow about from door to door and milk directly into the customers' receptacles. A form of cheese is made which resembles our cottage cheese, but is in reality more solid. Practically no butter is made, and indeed butter is but little used by the people of the island. Cattle enjoy much comfort in the island, suffer little from the heat, are quite free from the annoyance of noxious insects, and are seldom bothered by diseases. They range on luxuriant pastures and seldom want for abundance to eat and drink. Export cattle for beef sell for \$2.25 per arroba (25 pounds). This is discounted 40 per cent for shrinkage in dressing, which makes the price about \$5.40 per 100 pounds, corresponding very nearly with the prices in the United States. In recent years the price has been as high as \$3 per arroba, which equals \$7.20 per 100 pounds. The raising of live stock in Porto Rico may be considered a paying business as conducted for the past few years. The demand for some of the present pasture lands for the production of sugar will have a tendency to increase the cost of production.

The swine of the island are of a very inferior kind, being small and of the "razor-back," "rail-splitting" variety. They are commonly tethered out by a rope and get their living largely from grass and weeds, but are at times allowed to range in the tuber patches, where they can root up the yams, potatoes, etc., and they are also fed plantains and the small nuts that grow on the royal palms.

Goats are of the short-haired, milk-producing kind and are used for flesh and milk. They apparently do well.

Sheep are rather scarce and have comparatively little wool. It is probable that sheep for the production of wool would not do well in so warm and wet a climate.

Fowls, which consist chiefly of chickens, are small and active, the cocks being of the kind used for fighting. Eggs in the markets can seldom be purchased for less than 2 cents each, and chickens are as correspondingly high in price.

There is room for improvement all along the line of live stock, the demand being greatest in the case of the milch cows, horses, swine, and chickens. The essentials in such improvements will be the introduction of new blood, care in selection, and more rational methods in the feeding, care, and treatment of the animals.

INSECT PESTS.

Of the insect pests nothing is more pernicious than a mole cricket, known as "la changa." It is believed to have been introduced from Peru, and is very destructive to a wide range of plants in their early

growth or period of becoming established. It is especially troublesome in starting vegetables on sandy land. It works at night, burrowing beneath the surface of the ground and eating the young plants off just below the crown. In case of a lack of food it migrates during the night, even to a considerable distance, and continues its destructive work. On account of its nocturnal habits, its mode of flight, and working beneath the surface, it is a most formidable pest, and no doubt much patience, time, and ingenuity will be required to exterminate it. Methods of extermination by means of barriers of tar, by catching with traps, light, and by the use of fertilizers have already been inaugurated, but it is yet too early to know what ultimate success may be attained.

Scale insects, especially the purple scale and the chaff scale, are common on the orange, as are also several fungus diseases, among which may be mentioned verrucosis, melanose, and sphaerostilbe. In the interest of the orange planters these need immediate attention, which will be given as soon as the entomologist can spare the time.

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